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Adult of the beet webworm. Farm practices affect the pest's numbers. See story page 22.

Les travaux de la ferme réduisent la multiplication de la tisseuse de la betterave (Loxostege Stiticalis). Voir page 22.

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Agriculture Canada

IMPROVING SHORT-SEASON MAIZE

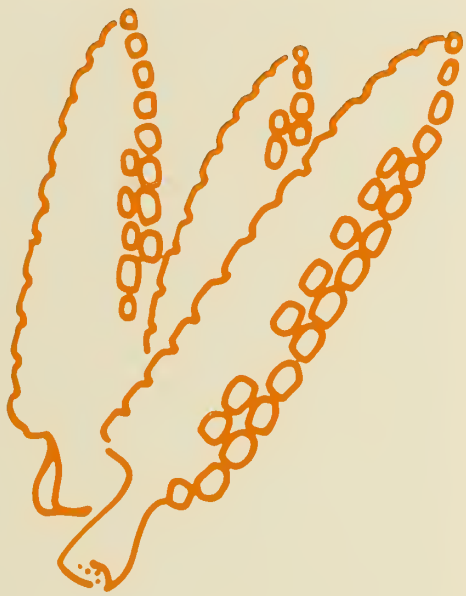
MORGAN S. CHIANG,
MARCEL HUDON
AND DANIEL CHEZ

Un programme de sélection du maïs grain précoce pour l'incorporation de la résistance à la Pyrale et à la fusariose a commencé en 1969. L'objectif est de créer des lignées de maïs grain en partant de matériel génétique obtenu dans le monde entier et évalué à ces fins. A l'aide de la méthode génétique dite sélection récurrente, de l'autofécondation et d'une pépinière en Floride pour continuer le travail pendant l'hiver, il est possible, après quelques années, d'obtenir pour les régions de l'Est du Canada, des lignées qui possèdent les caractères visés et un pouvoir germinatif suffisant à basses températures. La station de St-Jean est le seul centre gouvernemental canadien à poursuivre de telles recherches.

The acreage of grain maize in Quebec has steadily increased in the past decade, and today, with its 60 000 ha, the province is the second largest producer in Canada after Ontario.

In Eastern Canada, where the European corn borer has a single generation per year, it is the most important pest. Traces of a second generation in August have been observed in some areas of Quebec for the past few years. Larvae penetrate and bore into the maize plants from July until harvest resulting in a tremendous amount of tunnelling and breakage of stalks. The situation is different in areas having two broods. The economic value of the crop sel-

Dr. Chiang is a plant geneticist and Mr. Hudon is an entomologist at CDA's St. Jean, Que., Research Station. Mr. Chez is a plant pathologist for Agriculture Québec, Service des Productions végétales, Complexe Scientifique, Ste-Foy, Québec.



dom justifies insecticide treatment. Thus, breeding inbred lines resistant and/or tolerant to the corn borer became one of the main objectives of the St. Jean maize program.

Our studies on the inheritance of resistance to a single brood under Quebec growing conditions revealed that resistance to leaf feeding by the borer is polygenic. Additive gene action and the heritability of this character is high. In other words, the degree of resistance to leaf feeding can be increased by combining genes responsible for resistance from different sources of germplasm. Recurrent selection is one of the most effective breeding methods in such plant material.

Since 1969, we have screened hundreds of inbred lines and varieties from all over the world for resistance to the borer. Some lines were obtained from China through Plant Gene Resources in Ottawa and from the USSR through our participation in the International Cooperative Project on the corn borer. Some inbreds may have good resistance (antibiosis) during the early part of the growing season, but at harvest, they may be badly damaged by the borer; the phenomenon can also be reversed. To create a composite, a group of resistant lines/varieties selected from the screening tests were planted in an isolated plot for random inter-pollination. These composites have a heterogeneous germ pool with a relatively wide range of maturity but a high degree of resistance to leaf feeding and serve as a source population for our recurrent selection program. The procedures for creating composite and recurrent selection used at St. Jean are as follows:

1. CREATION OF COMPOSITES
   A number of lines/varieties selected from screening tests are planted in an isolated plot to allow for random inter-pollination.

2. RANDOM MATING
   Two to three generations of random cross-pollination are necessary. Neither infestation nor selection is made.

3. INFESTATION AND SELECTION
   Plants from a few hundred seeds obtained from the random mating population are artificially infested with corn borer egg masses and selfed. Select 10 of the most early resistant plants.

4. INTERCROSS (WINTER NURSERY IN FLORIDA)
   Seeds harvested from the 10 best selected plants are planted separately and all possible crosses are made (45 single crosses). Ears are harvested from plants individually.

...artificially infested

Susceptible plants at the whorl stage before tasselling. Sometimes the upper leaves become completely detached from the main stalk.

Resistant (left) and susceptible (right) maize inbred lines were artificially inoculated at the whorl stage.

1st cycle of recurrent selection

5. SELFING (SUMMER NURSERY IN ST. JEAN)
   Seeds obtained from the winter nursery are planted in ear-to-row fashion; based on earliness, 3-4 plants in each row are selected and infested with corn borer egg masses. Infested plants are selfed. At harvest, select 10 of the earliest most resistant plants for intercross in the winter nursery.
6. INTERCROSS (WINTER NURSERY)
   Repeat procedure 4.
7. REPEAT 5 AND 6 TO COMPLETE 2nd AND 3rd CYCLES OF SELECTION.
8. INBREEDING TO ESTABLISH 'MODERATE' INBRED LINES.
   When plants reached the mid-whorl stage, they were artificially infested with corn borer egg masses. Their number increased from 6 (about 120 eggs) per plant at the beginning of the program to 12. Leaf feeding resistance was recorded according to the international scale 1-9 (1 for the most resistant and 9 for the most susceptible) one month after the last egg deposition. Leaf feeding resistance is a good assessment of plant antibiosis to young borers. At harvest, total plant damage, particularly stalk breakage above or below the ear, and tunnelling were recorded for evaluation of plant tolerance to the borer.

To speed up the work, a winter nursery was established in Florida for the intercrosses. Plants selected from the third cycle of recurrent selection were subjected to inbreeding for 2-3 generations to establish 'moderate' inbred lines. During the inbreeding process, besides corn borer infestation, plants were also inoculated with stalk rot organism *Fusarium roseum* var. *graminearum* (Schawbe) Sn. et H. Only plants with a high degree of resistance to both the borer and stalk rot were selected. This year, plants will also be inoculated with the eye spot organism *Kabatiella zeae*, a disease that appeared recently in commercial corn fields in Quebec.

We have now established 4 composites designated Composite A, B, C and D. The effect of selection for earliness and leaf feeding of the first three composites are presented in the following table:

Composites A and B are now at the inbreeding stage. Composite D is still at the second random mating

Susceptible maize plants at harvest are broken below the ear as a result of corn borer attack.

Susceptible maize stalks are severely damaged by the corn borer.

Composites	Number of lines/ varieties	Leaf feeding scale 1-9				Days from planting to silking (earliness)			
		Original[a]	1st cycle	2nd cycle	3rd cycle	Original	1st cycle	2nd cycle	3rd cycle
A	9	1.9	2.5[b]	2.4[b]	2.1[c]	82	71	70	63
B	15	2.0	2.4[b]	1.4[c]	3.0[d]	79	66	55	60
C	17	1.7	2.3[d]			79	61		

[a] plants infested with 4 egg masses
[b] plants infested with 6 egg masses
[c] plants infested with 9 egg masses
[d] plants infested with 12 egg masses

stage. The 'moderate' inbred lines derived from composites A and B will be sent to Dr. L. S. Donovan of the Ottawa Research Station for testing of their general and/or specific combining abilities.

A new aspect of this program is the introduction of gene(s) responsible for early seed germination under low soil temperature into the resistant inbred lines. R. Martin, plant breeder at Macdonald College, is supervising this work and we think that hybrids created from such inbreds will cope with the wet and cool soil temperatures often found in Eastern Canada during the normal planting period.

The St. Jean Research Station is the only Canadian governmental institution involved in such a program of agricultural research on short-season maize. ■

THE CATTALO EXPERIMENT

D. G. KELLER

En 1964, le ministère de l'Agriculture du Canada a mis fin à ses essais de croisement du bétail domestique avec le bison d'Amérique du Nord. Les chercheurs estiment que les croisements de bisons ne sont pas vraiment avantageux au Canada puisque nous avons déjà des sujets consanguins et croisés possédant d'excellentes aptitudes et que la rusticité n'est plus aussi importante par suite des changements intervenus en matière d'affouragement d'hiver et de gestion. Cependant les bisons et les croisements issus de bisons pourraient s'avérer utiles dans les régions septentrionales, là où le bétail ne peut pas se suffire à lui-même et dans les régions caractérisées par de longues périodes de températures extrêmement basses, par la présence de neige, et par des infestations d'insectes.

Fertile 21-year-old Hereford × bison hybrid cow.

Agriculture Canada initiated a species-crossing experiment with domestic cattle and North American bison in 1916 when 16 cows (25-75% bison) and 4 bulls (25-75% bison) were purchased from a private breeder in Ontario. This marked the beginning of the cattalo project. The herd was moved from Scott, Sask., to Wainwright, Alta., in 1918 and remained there until it was transferred to Manyberries, Alta., in 1949. The project was terminated in 1964.

The intention of the cattalo project was to produce a range animal containing predominately domestic blood of improved beef cattle with sufficient bison blood to retain their hardiness and foraging ability during spells of inclement weather.

The first crosses between bison and domestic crosses with no differentiation as to the sire or dam species were named catalo or, more commonly, hybrids, and were 50% bison-50% domestic. Crossing hybrid and part-bison females back to bison sires produced animals termed catfalo that were greater than 50% bison. Domestic sires bred to hybrid and part-bison females produced the first cattalo that were greater than 50% domestic. However, true cattalo were considered to be progeny of parents that were both cattalo.

Several breeders near the turn of the century crossed bison bulls with domestic cows of various breeds to produce hybrid calves. This practice was repeatedly described as violent as it usually resulted in death of both cows and calves. One breeder in 1888 claimed to have lost 30 cows while obtaining 4 calves as a result of breeding 6 bison bulls to 90 domestic cows. Hybrid males from domestic dams were also fewer in number than hybrid females as the males were either aborted or stillborn and those that survived, unlike the females, were sterile.

The original herd purchased by Agriculture Canada failed to reproduce from 1916 to 1924, perhaps because of overconditioning, stress due to change of environment, and advanced age. Therefore the experiment started anew in 1925 with the reintroduction of more bison and domestic cattle representing Shorthorn, Angus, Hereford, and Holstein

Dr. Keller researches beef cattle breeding at CDA's Lethbridge, Alta., Research Station.

Fertile 3-year-old cattalo cow (14% bison).

Fertile 5-year-old cattalo bull (12.5% bison).

breeds. By 1929, it became apparent that many of the problems of cow-calf deaths at calving could be prevented by breeding domestic sires to bison, hybrid, and cattalo cows instead of the opposite cross to produce the cattalo herd. Crossing back to domestic sires became the practice until some 6% to 18% bison bulls were found to be fertile and able to mate to hybrid and cattalo cows. By 1949, 39 domestic-bison hybrid cows and 85 cattalo cows (12-25% bison) plus bulls and calves made up the cattalo herd when it was transferred to Manyberries.

After the move, cattalo were evaluated for thriftiness, hardiness and reproductive capabilities, and for their beef-producing qualities compared to Hereford cattle.

In the fifties, it was established that cattle × bison hybrids and cattalo foraged on open range more frequently under unfavorable conditions than domestic cattle. Because of their behavior and thicker hair coats, they were less affected than Herefords by high winds and low temperatures and were less prone to drift with the wind during blizzards. Hybrids, and to a lesser extent, cattalo, had finer hair and more fibers per unit area than Herefords and, consequently, they were more cold resistant than domestic cattle.

Bison females did not breed as yearlings as did hybrid, cattalo, and Hereford females. However, conception rates among part-bison cows approached that of Hereford cows although the former weaned fewer calves; the lower proportion of part-bison male calves born alive accounted for most of this difference. Birth weights of calves were less as the percentage of bison in the dams increased. This trend was especially marked in calves that died before

...genetic incompatibility

Fertile 2-year-old cattalo bull (19% bison).

weaning. In spite of lower birth weights, hybrid and cattalo cows weaned calves as heavy or heavier than Herefords which suggests that part-bison cows give greater milk than Hereford cows.

In terms of total productivity, including the number of calves born per cow, the proportion of calves surviving to weaning, and mean weaning weights, Hereford and hybrid cows were about the same and each surpassed the productivity of the cattalo cows.

As yearlings, the majority of bison, hybrid, and cattalo bulls were found to produce little or no sperm. Reasonable fertility was attained in some bulls with as little as 12% to 18% bison breeding at Manyberries. The infertility of part-bison bulls is undoubtedly an indicator of the genetic incompatibility of crossing domestic cattle with bison and it may be the underlying cause of the unacceptable breeding performance of hybrid and cattalo bulls.

In rate of gain and efficiency of gain in the feedlot, Herefords were superior to cattalo, which in turn exceeded bison. Early studies showed a reduction in proportion of carcass in the hind quarters, lower degree of finish, and an increase in dressing percent as the percentage of bison increased. Later studies have shown that calves averaging about 14% bison were exceeded by Hereford in slaughter weight, rate of gain, and efficiency of gain in the feedlot. However, in terms of carcass potential, few differences existed between cattalo of 14% bison and Hereford in proportion of primary retail cuts in the carcass.

Mortality, sterility, mating indifferences, difficulty in obtaining sufficient number of bison, and calf crops as low as 10% soon disillusioned early hybridizers and potential breeders of part-bison cattle. In spite of these obstacles, Agriculture Canada established an experimental cattalo herd and studied its performance and behavior. It became well established that cattalo exceeded Hereford in their ability to withstand extremes in the weather. However, the overall performance of cattalo was somewhat inferior to that of Herefords.

Modern-day attempts to cross domestic cattle and bison can emphasize performance in the selection of foundation bison females and domestic bulls. Previously untried crosses with other breeds could also improve growth rate of the crosses. Artificial insemination could circumvent the mating indifference and incompatibility problems. The lower reproductive rates of females and poor fertility of males will be more difficult to solve. There is probably little advantage in bison crosses in Canada where we already have a variety of high-performing straightbreds and crossbreds and where extreme hardiness is not as critical as it used to be because management systems and winter feeding patterns have changed.

The bison and bison crosses could possibly find a niche in northerly latitudes where cattle could not fend for themselves, where extreme cold and snow cover are common for long periods, and where insect infestations occur. ■

X-DISEASE OF PEACH

WAYNE R. ALLEN

La culture du pêcher a cessé dans les régions où il est difficile de supprimer le cerisier à grappes qui lui transmet le virus-X. Un antibiotique injecté dans l'arbre fournit une complète rémission des symptômes et une récolte normale dans les vergers ravagés.

X-disease is one of the oldest and most widespread disorders of peach trees in this country. It was reported as early as 1933 in the eastern United States and was probably sufficiently prevalent to be of some concern to Ontario peach growers by the late 1930's. However, it was not officially reported, until 1941. The disease can also infect sweet and sour cherry and plum, in addition to a range of other Prunus species.

The disease occurs widely in North America and is not confined to fruit-growing areas. This is because chokecherry, a widely distributed species, is the primary host of the disease organism. The presence of X-disease in fruit growing areas is first detected, in many instances, by finding infected chokecherries which develop bright orange to red foliage in late summer, long before normal coloration commences.

Identification of the disease in peach is often difficult when symptoms first appear. The yellow or red irregular spots and blotches that appear on the leaves may easily be mistaken for nutrient deficiencies caused either by improper management practices or by fungal or bacterial cankers that interrupt the flow of nutrients through the branches. Soon after the leaf spots appear and begin to enlarge, the affected shoots become a slight yellow color and the foliage appears sparser than normal due to cupping of the affected leaves. Shortly thereafter, the yellowish-red spots begin to fall out of the leaves and premature leaf drop occurs, except at the terminals where a few leaves persist in rosetted tufts.

Fruit set on newly infected branches may appear normal at first, but most of the fruit drops prematurely. The few fruits that remain have a bitter flavor. Within a year or two, the entire tree can become affected; the resultant decline in vigor contributes to winter-kill of branches and finally the tree dies.

For a long time the causal organism of X-disease was thought to be a virus. However, electron microscopy finally revealed that the causal organism was a mycoplasma. This organism appears to assume various shapes as seen in tissue sections. The bodies may be filamentous or spherical depending on the particular section under view. The mycoplasma is apparently confined to the phloem cells and moves easiy from cell to cell through sieve plates. The effect of the disease on the tree results from plugging and death of the phloem cells whose primary function is to transport nutrients. Some disorganization of the phloem layer has also been noted which is caused by hypertrophy and hyperplasia of the phloem parenchyma.

The mycoplasma is transmitted to peach trees by several species of leafhopper which acquire the organism by feeding on infected chokecherries. These insects are efficient disseminators of the organism because they are strong fliers and once having acquired the mycoplasma they can carry and transmit it throughout the growing season. These leafhoppers do not normally feed on peaches, but they do come

Dr. Allen is a fruit virologist at CDA's Research Station, Vineland, Ont.

...increasing annually

Left, X-diseased peach tree receiving antibiotic solution in August, 1975. Right, treated tree in August, 1976, after removal of dead branches.

into contact with the fruit trees during their numerous flights from woodlots and fencerows where chokecherries normally grow.

Surveys in diseased peach orchards in Ontario have indicated that annual increases in the number of infected trees in specific orchards range up to 5%, with apparent exceptional increases of as much as 30%. However, because 1 or 2 years may be required before initial symptoms are evident, the high spread figures may actually represent influx of the disease over several years. In the major peach-growing areas of Ontario, it is estimated from survey data and from reports by growers and extension personnel that the disease is present in over 70% of the larger orchards. Moreover, peach growing has ceased in areas where extensive tree losses have occurred because of the difficulty of eradicating chokecherries. For example, many formerly productive peach orchards situated close to the heavily wooded Niagara Escarpment have now been converted to alternate crops such as grapes.

Disease control has been and currently is based primarily on eradication of infected chokecherries and removal of diseased peach trees. In the latter case, there is no proof that the disease is spread from peach tree to peach tree, but dying trees are unprofitable and their removal seems advisable.

In recent years, scientists in the United States and Canada have shown that by treating diseased trees with antibiotics, the symptoms disappeared and normal fruit production was restored. The treatment involves either spraying oxytetracycline-HCl onto the foliage or infusing it into the tree trunks. The latter method is preferable. It consists of boring three small holes, usually below each of the major scaffold limbs, and inserting tubing which is connected to a reservoir holding the antibiotic solution. After the liquid has entered the tree, the holes are covered with a wound dressing.

Treatments are best done immediately after harvest so that the chemical residues have a full year to dissipate. Dosages as low as 100 mg of active ingredient given once have caused complete symptom remission the following year. A single application of as little as 400 mg has given complete symptom remission and normal cropping for a two-year period without detectable chemical residues in the fruits.

The cost of the chemical for a single 400 mg treatment is currently about 20¢. When the chemical is approved for use, the grower will have a rapid, inexpensive, and effective method for prolonging the productive life of X-diseased peach trees. ■

WORN-DOWN PEATS AND MUCKS

S. P. MATHUR

Les recherches menées par le ministère de l'Agriculture du Canada à Terre-Neuve et dans le sud-ouest du Québec ont montré que l'addition de cuivre aux sols organiques en réduit l'affaissement.

Researchers at Agriculture Canada believe that adding copper to organic soils may be a practical, economic, safe method of restraining the soils' subsidence.

Agricultural organic soils (peats, mucks, histosols) are obtained by draining and cultivating marshes, fens, moors, mires and bogs. Organic deposits like these are more prevalent in Canada than anywhere else except the U.S.S.R.

The continual slow fall in the surface elevation of organic soils is generally called subsidence. It usually results from decomposition of organic matter through biochemical and chemical processes, although physical shrinkage may also contribute. This transformation occurs as a result of complete degradation of organic matter to carbon dioxide and water (mineralization) and because the residual material is transformed to dark, less fibrous, more compact humus. Decomposition is faster in warmer climates, and the proportion of humified residue varies with the nature of the starting material. Rate and extent of subsidence is also influenced by water management practices. The rates of subsidence reported from different locations (Finland to Greece, and Ontario to Florida) range between 1 mm and 80 mm/yr.

There is ambiguity about the rate of subsidence of organic soils in Canada. About 15 years ago it was predicted that the Holland Marsh would subside about 3.3 cm every year. Regular measurements since 1963 by a permanently installed sensitive instrument have revealed that the rate of subsidence between 1963 and 1975 was only 1.07 cm/yr. One of the best ways of minimizing subsidence is practised here — the water table is kept relatively high.

In contrast to the Holland Marsh, most organic soils in southwestern Quebec are freely drained. A research worker (J.A. Millette) at the Agriculture Canada Research Station at St. Jean has measured subsidence in this area. On the basis of average difference between an elevation recorded in 1936 and in 1974, it can be estimated that an organic soil on a site in southwest Quebec has subsided at a rate of 2.07 cm/yr.

Subsidence threatens all organic soils used for agriculture in Canada. Most of these soils grow vegetables. The roughly 3000 hectares in Holland Marsh produce about 0.72 hectolitres of vegetables for every man, woman and child in Canada.

Agriculture Canada realized that many of the methods recommended for controlling subsidence, such as maintaining a high water table, low pH, and minimal tillage, were not widely accepted because of high risk, cost, or infeasibility. Consequently the department launched a joint research project on organic soils in 1974 involving the Soil Research Institute in Ottawa and the St. Jean Research Station, with cooperation from other stations such

Photo of Keswick Marsh shows subsidence of the surface of cultivated muck on the right compared to uncultivated, partly drained marsh on the left.

Dr. Mathur works in the Organic Soils Program of CDA's Soil Research Institute in Ottawa.

...copper retained

as St. John's, Nfld. Among other goals, the purpose of the study was to find economic, practical means of mitigating the subsidence of organic soils.

It was noted by Mathur and Rayment in an ongoing field experiment in Newfoundland that the rate of decomposition, and thus mineralization microorganisms of a poorly humified organic soil (peat), decreased where eight annual fertilizations with copper and other trace metal elements had been made. Analyses showed that of the elements added, copper was retained the most. This metal was probably involved in inhibiting the decomposition of the peat. This observation was confirmed by measuring the changes in bulk densities of the experimental pasture plots during the eight years. Bulk density of an organic soil increases as mineralization and humidification progress.

To understand the inhibitory effect of copper, many experiments were made with additions to many soil samples of an enzyme, a non-enzymic protein and metals. Results indicated that the residual fertilizer copper slowed down decomposition because it accelerated the inactivation of certain exocellular degradative enzymes in the soil. Such enzymes tenderize meat and help malt barley to brew mash. Soil enzymes also play an important role in decomposing organic matter.

Subsequently, workers (Mathur and Sanderson) in the Soil Research Institute attempted to determine whether copper applications have influenced the decomposition of organic soils in southwest Quebec. Samples of 17 fields were collected on the same day between rows of crops in the summer of 1976 near Ste. Clothilde, Que. It was found that the higher the copper content of soils, the slower was their rate of decomposition as measured in the laboratory at 21°C. Also, the activity of a decomposing enzyme was lower in samples with higher copper contents. These results were confirmed by data obtained by analysis of samples of seven fields collected from the same area in the fall of 1976 when the fields were bare. In all, 33 properties were examined for possible correlations. The results indicated that copper application (at a few quintals per ha) should be investigated as a means of curtailing the decomposition and subsidence of some organic soils.

In a field at Ste. Clothilde, the relative rate of decomposition under natural conditions was found to fall by two-thirds as the copper content increased from 0.015% to 0.030%. This was revealed by measurements made in the field through the cooperation of scientists at St. Jean (Hamilton) and the Soil Research Institute (Lévesque and Mathur). Preliminary results indicate that these observations may have relevance for Keswick, Bradford, Colbar, Holland and Leamington marshes of Ontario as a practical aid for reducing the rate of subsidence.

This staircase was built on more organic soil than the deeper foundation of the building Subsidence of the soil caused the staircase to sink away from this building at Holland Marsh. (The black and white marks on the pole by the railing are 10 cm each.)

Further field trials are being planned, initially for the Ste. Clothilde Substation. Copper application at less than 100 kg/ha will be investigated for suitability as a method of mitigating the biochemical oxidation and thus the subsidence of some organic soils, particularly those recently-opened.

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CARACTÉRISER LA STRUCTURE DES SOLS

C. DE KIMPE

Soils specialists at the Ste-Foy Research Station use two laboratory methods to study the porosity of Quebec soils. The first measures the suction or pressure needed to extract water from the soil; the second measures the force required to force mercury into the soil. Such studies allow for a better understanding of soil structure and water exchange systems, and should prove valuable to drainage specialists.

La capacité d'échange du sol varie avec le type de profil et variera aussi à l'intérieur d'un profil.

Le système canadien de classification des sols repose sur certaines propriétés fondamentales qui servent également à caractériser la fertilité naturelle des sols.

Parmi ces propriétés, le développement du complexe d'échange et de la structure ont aussi un impact déterminant pour l'agriculture. Considérons brièvement trois ordres de sols représentés au Québec: les luvisols, les podzols et les gleysols. Dans les premiers, il y a migration des particules fines des horizons de surface et accumulation dans un horizon plus profond; dans les seconds, il y a dissolution des minéraux primaires par les acides organiques dans les horizons superficiels, puis migration et accumulation en profondeur de complexes, organo-minéraux; enfin, dans les troisièmes, il y a accumulation de matière organique peu décomposée en surface et peu de migration de particules en profondeur.

On sait que la capacité d'échange correspond à la possibilité de fixation et d'échanges d'ions à la surface des particules organiques et minérales. La matière organique a une capacité d'échange élevée tandis que les particules minérales colloïdales, les argiles, ont une capacité d'échange moins forte et sont fonction aussi de la nature des argiles. La capacité d'échange du sol va donc varier avec le type de profil et elle variera aussi à l'intérieur d'un profil. Or c'est sur ces sites d'échange que sont retenus les éléments fertilisants avant d'être utilisés par les plantes.

La disponibilité des ions retenus sera donc fonction de la facilité avec laquelle le système radiculaire des plantes va pouvoir se développer dans le sol. Il faut ici faire intervenir le concept de structure du sol.

La structure concerne le mode d'assemblage des éléments constitutifs du sol, soit la matière organique et les particules minérales, sable, limon et argile. L'assemblage des grains va donner les éléments structuraux de forme et de taille variables, et on trouvera des types particulaire, granulaire, lamellaire, polyédrique, angulaire, subangulaire, prismatique et massif. Ces modèles structuraux peuvent eux aussi être associés à certains horizons (par exemple, structure granulaire dans un horizon B-podzolique, enrichi en complexes organo-minéraux et de faible densité, structure polyédrique dans un horizon d'accumulation d'un luvisol, et densité élevée à cause du colmatage des pores par les éléments fins).

Ceci permet de comprendre pourquoi la structure est un élément important de classification. Il est essentiel de mieux la caractériser. A cette fin, monsieur Christian De Kimpe et d'autres chercheurs, spécialistes en sol à la Station de Ste-Foy, utilisent deux méthodes pour étudier en laboratoire la distribution des pores dans le sol.

La première méthode, plus classique, fait appel à la rétention d'eau. Partant d'un échantillon saturé en eau, placé sur une table de tension ou dans un appareil extracteur à pression, les chercheurs étudient la succion ou la force nécessaire pour extraire l'eau du sol. Comme dans une éponge imbibée d'eau, plus les pores sont petits, plus la rétention est forte et plus grande sera donc la force nécessaire pour enlever l'eau. Par pesées ultérieures, ils

M. C. De Kimpe est scientifique à la Station de Recherche, Agriculture Canada, Sainte-Foy (Québec).

déterminent les quantités d'eau extraites.

La seconde méthode est la méthode de pénétration du mercure. Le mercure est un liquide non mouillant, c'est-à-dire que contrairement à l'eau, il ne tendra pas à pénétrer de lui-même dans le volume poreux du sol. On doit l'y forcer en exerçant une pression qui sera de plus en plus forte à mesure que les pores seront plus fins.

Selon monsieur De Kimpe, il est possible, grâce à l'une ou l'autre de ces méthodes, de connaître la distribution des pores dans le sol et les chercheurs espèrent améliorer l'étude des propriétés structurales, qui sont encore fort subjectives.

«A partir de là, souligne-t-il, on pourra fournir des renseignements plus rationnels aux spécialistes du drainage au Québec. Encore nous faudra-t-il déterminer quel sera, à long terme, l'influence du drainage sur l'évolution des profils. Il y aura certainement des changements et ceux-ci pourront même peut-être modifier certaines pratiques culturales». ■

IMPROVED RANGELAND SEEDING EQUIPMENT

A. McLEAN, T. WINDT,
A. BAWTREE, and
D. WALDERN

Les personnes susmentionnées ont mis au point un appareil capable d'ensemencer les parcours de Colombie-Britannique recouverts de gravier, de caillous, d'arbustes ou de végétation dense. L'appareil se compose de deux machines, tirées en tandem et nécessitant un seul passage: une déchaumeuse lourde à doubles disques déportés (binage et ameublissement du sol) et un semoir mobile à rouleau plombeur (compactage et ensemencement).

Drs. McLean and Waldern are scientists at CDA's Kamloops, B.C., Research Station. Mssrs. Windt and Bawtree are with the B.C. Ministry of Agriculture.

Seeding depleted British Columbia rangeland to grasses and legumes has always been difficult because there was no machinery to handle the task effectively. Now there is.

Fred Feistmann and Tom Windt of the Agricultural Engineering Branch, British Columbia Ministry of Agriculture, have produced the equipment under a contract from CDA's Development, Research and Evaluation of Agricultural Machinery program (DREAM).

They set out to develop something that would do a thorough job of tillage on undulating topography containing significant amounts of gravel or rock, shrubs or dense woody cover such as that found on B.C. rangelands. Such tillage normally should not exceed 8 to 10 cm in depth, and should leave the seed bed in good tilth. The equipment also had to accurately place and cover the seed for maximum soil-seed contact and moisture retention. All this had to be accomplished in one pass over the range to keep the cost down.

The equipment they developed has two basic units: a flexible heavy-duty double offset disc for control of vegetation and soil tillage, and a free-floating seeder-packer to compact the soil and place the seed accurately. The two units are pulled in tandem for a once-over operation.

The unique feature of the offset disc is the floating gang design. Each 3.6 m gang is made up of four individually suspended sub-gangs.

The sub-gangs are controlled and loaded by a hydraulically operated cylinder.

Individual sub-gang suspension and hydraulic loading provides a number of advantages:

— infinitely variable loading — 0 to 378 kg per disc with control at the tractor seat;
— good flexibility to accommodate uneven terrain and obstacles such as boulders and rock outcropping;
— extended flexibility to follow severe contours;
— increased durability — individual sub-gangs absorb the impact of an obstacle, rather than lifting the machine;
— more freedom from plugging with big sagebrush and similar material due to the relative motion between adjacent sub-gangs.

The seeder-packer consists of two sets of rollers. Both front and rear roller assemblies are made up of four packer sections. Each of these sections is individually suspended from the frame to provide plus or minus 0.3 m vertical displacement. The two rear outside drums are solidly mounted for machine stability and transport. Seed is broadcast between the rollers from a standard seed box. The second set of rollers is offset to split the shallow ridges formed by the front rollers and firm the soil around the seed for maximum soil-seed contact. On gentle sloping terrain, a D6C crawler tractor has adequate power to propel the 9072 kg disc and 6350 kg seeder-packer. When severe slopes are encountered, a late-model D7 or equivalent crawler tractor should be used.

Field trials were undertaken during the 1977 season. Over 688 ha were seeded at various locations from the Okanagan to the Chilcotin, 405 ha of these in one block. Under good conditions it was possible to cover up to 1.6 ha per hour. The equipment operated satisfactorily and grass establishment has already been noted at some locations. In some cases where existing weed cover formed a dense sod, double discing was necessary to obtain maximum benefit from the seeder-packer. Depth of seeding was good. Seed distribution was excellent except under high winds. It was noted that effectiveness of packing was important in determining speed of germination and establishment. The cost of seeding with the new equipment is estimated to vary from $75 to $110 per ha, depending on tillage requirements. ■

Fred Feistmann and Tom Windt ride the new seeder-packer with the tandem disc attached on the front.

DETECTING VIRUS A IN POTATOES

R. P. SINGH

Les recherches menées à la station fédérale de Fredericton ont montré qu'au moins trois espèces du genre *Physalis* peuvent différencier les virus presque identiques A et Y de la pomme de terre. En prélevant des feuilles d'un grand nombre de plants de pomme de terre, il est possible d'en tester la sève qu'on incubera pendant une semaine. Cette méthode simple permettra de tester de façon intensive les semences et d'éliminer le matériel infecté lorsque la pomme de terre ne montre aucun symptôme de la maladie.

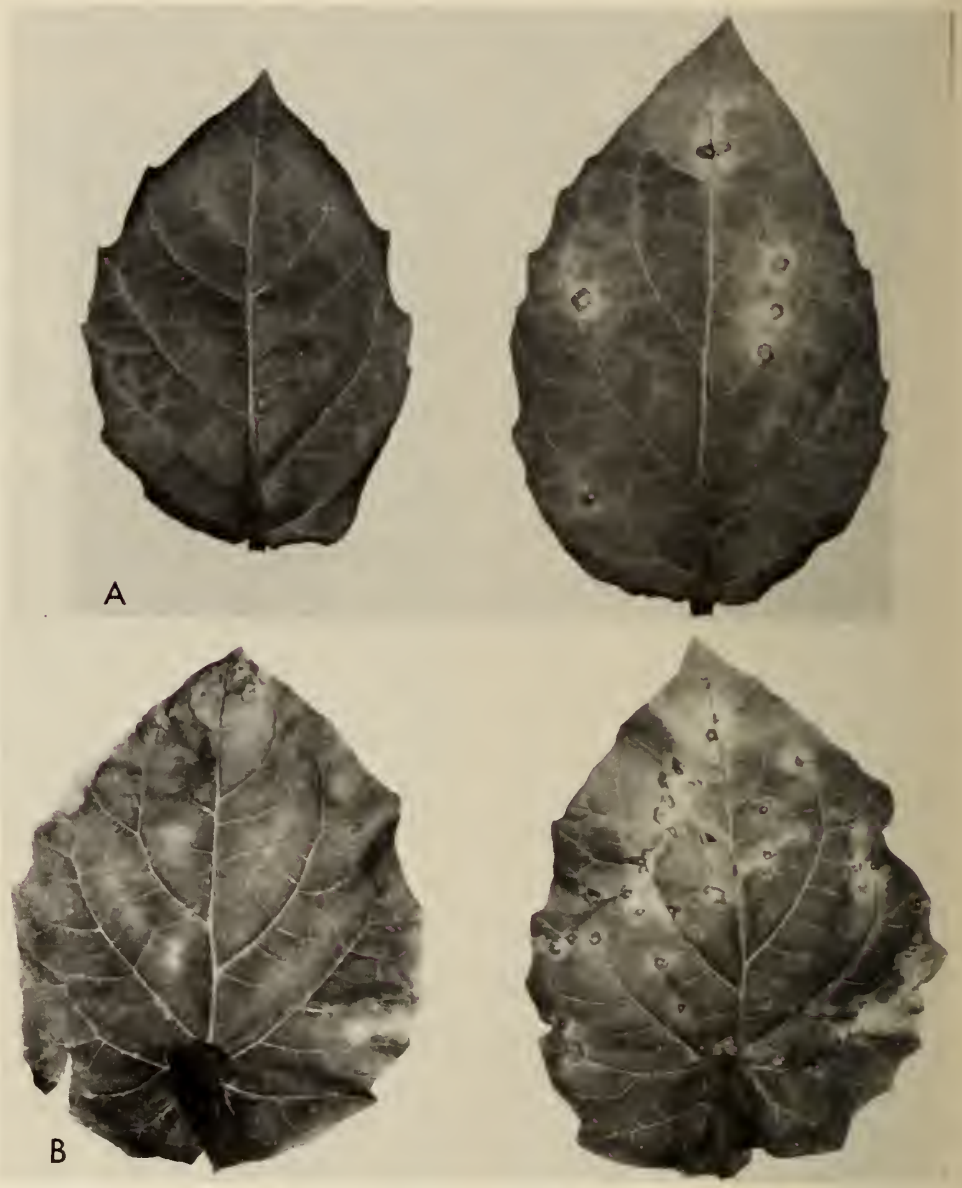
Plant scientists and virologists continue to investigate plant-virus interactions in many agricultural crops, using hundreds of weeds and ornamentals as 'informer' or indicator plants. These indicators are usually not related to the 'patient' crop family.

At least 30 different viruses are pathogenic to the potato. Many do not produce visible symptoms; but if they do, the expression of several infections may result in a confused pattern and preclude identification of a particular virus.

When juice from an infected potato plant is rubbed on, or injected into, an indicator plant, the virus is transferred and the indicator 'blows the whistle.'

Clear-cut symptoms, ranging from minute necrotic or chlorotic dots to streaks or dead patches, develop on the leaves. Whatever the signs, with a good indicator they are highly specific for an individual virus. The expression of symptoms in the leaves of the indicator plant confirms infection in

Dr. Singh is a plant virologist at CDA's Fredericton, N.B., Research Station.



Two species, i.e. *Physalis angulata* (A) and *Physalis pubesence* (B) with necrotic local lesions on the right, and healthy leaves without lesions, although infected with potato virus Y on the left.

Right, *Physalis floridana* leaf showing necrotic lesions followed by inoculation with potato virus A; Left, healthy leaf.

Two seed lots of *Physalis pubesence* developing different types of leaves but both showing local lesions due to PVA but not with PVY.

the potato as surely as an eyewitness spots a criminal's photograph in a police file.

The search for indicator plants becomes an integral part of virus identification. Some viruses (for example, potato virus A (PVA) and potato virus Y (PVY)) are so similar in their morphology, in their mode of transmission, and in symptom expression that only specific indicator plants can settle the dispute when a potato field is infected with both viruses simultaneously. At the Agriculture Canada Research Station in Fredericton, we have been testing several plants for the reliable separation of these two viruses.

We have found such a plant — the groundcherry, *Physalis floridana* Rydb. Some plants in a seed potato field developed mosaic symptoms; to identify the cause, a series of indicator plants was inoculated, including groundcherry. To our surprise, this plant developed necrotic circular spots on the inoculated leaves. It was known that groundcherry produces necrotic local lesions with potato viruses X and Y, but in this particular case both of these viruses were absent. By inoculating groundcherry plants with individual viruses we learned that the necrotic spots in question were those of virus A. A quick search of literature indicated that this had happened before, but the plant had not been domesticated enough to respond to the research.

We accepted the challenge of domesticating the groundcherry so that it could be used for large-scale detection of virus A. Growing the groundcherry under diffuse light and then in total darkness for 12 to 24 hours provided a suitable indicator plant for virus A. By detaching the leaves after inoculation and in-

cubating them in a tray of water, the confusion caused by the presence of potato virus Y was eliminated. Under these circumstances, virus Y did not develop necrotic spots, although the detached leaves were infected. Thus, groundcherry turned out to be an effective indicator plant for detection of virus A even in the presence of virus Y infection.

Next, we turned our attention to the examination of some close relatives of the groundcherry. Six additional species belonging to genus *Physalis* were tested with both virus A and virus Y. *P. angulata* and *P. pubesence* developed necrotic local lesions when infected with virus A but not with virus Y.

Thus, within the genus *Physalis*, at least three species are capable of differentiating the closely related potato viruses A and Y. The use of detached leaves permits testing of large numbers of potato plants by extracting the juice from potato leaves and rubbing it on the detached Physalis leaves and incubating for one week. This simple test will facilitate extentive testing of seed stocks and provide a means of eliminating infected material when the potato shows no symptons of virus infection. ■

CULL POTATOES AND TIMOTHY HAY LET BEEF CATTLE PAY THEIR WAY

J. W. G. NICHOLSON

La pomme de terre et la fléole sont les deux aliments du bétail les plus courants dans les Maritimes. Une fois mélangés, dans les proportions appropriées, avec des compléments protéiques, minéraux et vitaminiques, ils constituent une ration de croît et d'engraissement économique pour l'élevage des bovins de boucherie.

Two of the most common feeds available on Maritime farms are cull potatoes and timothy hay. Properly combined with supplementary protein, minerals and vitamins, they make an economical growing-fattening ration for beef cattle.

Dr. Nicholson is an animal nutritionist at CDA's Fredericton, N.B., Research Station.

Beef cattle fed on potatoes and long timothy hay at the Fredericton Research Station have gained a kg per day at a retail feed cost of about 60¢. Feed costs represent about 80% of the total costs of raising beef cattle; therefore, the cost of gain was about 75¢ per kg. During the past year, A 1 - A 2 slaughter steers have been selling in the $1.00 per kg range, resulting in a significant profit even in a year of low beef prices.

Recent experiments at Fredericton have been designed to find ways of improving steer performance when fed potatoes and timothy hay. Research at the Melfort Research Station and elsewhere has frequently shown increased daily feed intake and faster rates of gain of ruminant animals when forages are ground and pelleted.

In one experiment second-cut timothy hay was fed either (1) long, (2) ground through a 1.25 cm screen in a hammermill, (3) ground as above and moistened with 50% of its weight of water the day before feeding, (4) ground as above and mixed with the daily allowance of pulped potato the day before feed-

ing, or (5) ground as above and pelleted using a 0.7 cm diameter die in a commercial type pellet mill. All of the beef calves (230 kg average weight at the start) were fed 12.5 kg of potatoes and 0.5 kg of a commercial protein-mineral-vitamin supplement per head per day. In addition they were fed hay ad libitum from one of the five treatments outlined above. Except for treatment 4, the potatoes were fed whole in the morning, followed immediately with the supplement. This sequence of feeding assured optimum utilization of the non-protein nitrogen which made up 45% of the equivalent crude protein in the supplement. Hay was fed later in the day in amounts that the animals would barely clean up by the next feeding time. The average hay consumption and weight gains of the 10 calves on each treatment are shown in Table 1.

Grinding the hay resulted in a nonsignificant intake increase, while moistening the hay with water or mixing it with pulped potatoes to reduce dustiness resulted in the same intake as long hay. Grinding and pelleting resulted in a highly significant ($P \leq 0.01$) increase in intake and in rate of gain.

The feed cost of gain using the long hay diet was estimated to be 60¢ per kg. Using the same basic feed costs it can be shown that up to $31.50 per tonne can be spent on grinding and pelleting timothy hay before the feed costs of gain on treatment 5 will equal the feed costs when long hay is fed.

TABLE 1. HAY CONSUMPTION AND WEIGHT GAINS OF BEEF CALVES FED TIMOTHY HAY PROCESSED FIVE WAYS

Hay treatment	Hay DM consumed	Weight gained
	kg/head/day	kg/head/day
1 Long	2.90	1.00
2 Ground	3.15	1.05
3 Ground-moistened	2.90	1.10
4 Ground with pulped potato	2.89	1.02
5 Pelleted	4.01**	1.32**

**Significantly different, $P \leq 0.01$

Cull potatoes are an excellent energy feed for cattle.

Whole potatoes are a highly palatable feed for cattle and have been consumed at rates of up to 12% of body weight by steers on our experiments. To prevent digestive upsets the level of feeding must be increased gradually as potatoes are a high energy feed with very little fiber content. Potatoes are a substitute for grain rather than silage or hay in cattle rations.

Potatoes commonly contain just over 20% dry matter so it is necessary to feed about 4.5 kg of potatoes to get as much dry matter as in 1 kg of grain. On a dry matter basis potatoes have a similar feed value to corn. Both are high energy feeds, relatively low in protein (~ 9.0%), low in fiber, fat-soluble vitamins and certain minerals, especially calcium and magnesium. All these nutrients must be supplied in the supplement or other feeds included in the daily ration.

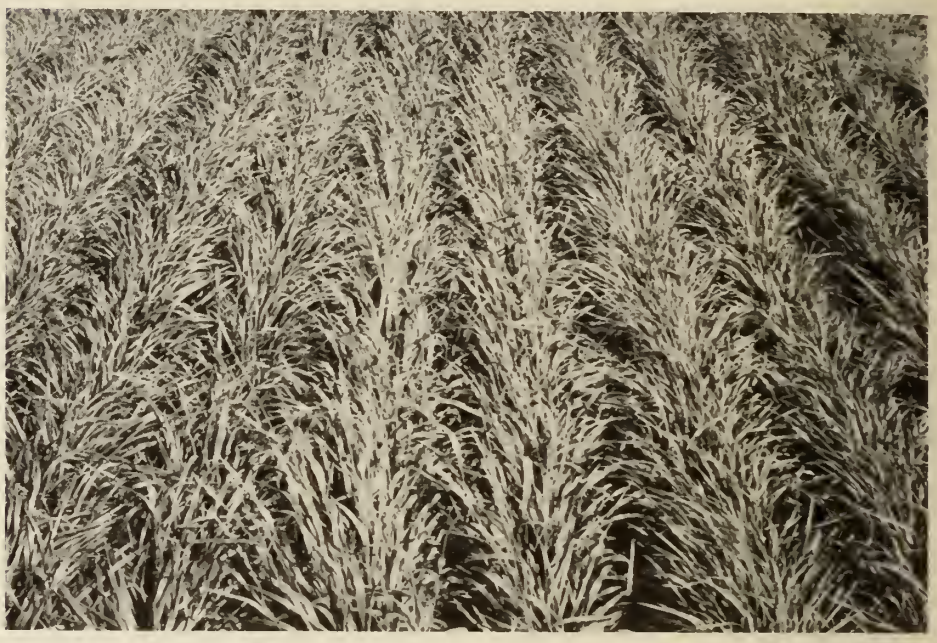
Surplus and cull potatoes are a disposal problem to growers. Frequently they are dumped in any convenient out-of-the-way spot where they may grow and become a source of disease for the new crop or they may break down and contaminate ground water or streams. A much better way of disposal is as cattle feed.

Cull potatoes and timothy hay
Let beef cattle pay their way.
If you dump them in the bay
You may live to rue the day. ■

ITALIAN RYEGRASS AS A SUMMER ANNUAL

H. T. KUNELIUS

Des recherches sur le Ray-grass d'Italie en tant que culture fourragère à croissance rapide ont été entreprises en 1972 à la station de recherches de Charlottetown. Les résultats des expériences et des pratiques montrent que le Ray-grass donne d'excellents rendements (pouvant atteindre 10 tonnes de matière sèche à l'hectare) en fourrage de bonne qualité lorsqu'il est cultivé comme annuelle d'été. C'est une bonne culture d'appoint ou de secours qui peut alterner dans les rotations courtes avec des cultures comme la pomme de terre



Leafy Italian ryegrass ready for fall grazing

Italian ryegrass is a temperate species that remains productive for from one to several years depending on the variety and environmental conditions. In Atlantic Canada, with adverse conditions for overwintering, Italian ryegrass behaves as a summer annual. It is not grown extensively in the Maritime Provinces where it is included in some forage and lawn mixtures and there is a limited area seeded in pure stands.

Research on Italian ryegrass as a short-term forage crop was initiated in 1972 at the Charlottetown Research Station. Experimental results and practical experience indicate that it produces high yields, up to 9.1 t dry matter per hectare, of good quality forage when grown as a summer annual. It makes a suitable supplementary or emergency crop and it can be used in short-term rotations with crops such as potatoes.

Two forms of Italian ryegrass have been included in experimental work at Charlottetown. *Lolium multiflorum*, Italian ryegrass, is a short-lived perennial, but because it is not dependably winterhardy we use it as an annual. It remains mostly vegetative during the seeding year. *Lolium multiflorum* var. *westerwoldicum*, Westerwolds ryegrass, is an annual or biennial and produces numerous reproductive tillers throughout the growing season. In Charlottetown, Italian and Westerwolds ryegrasses have had about equal dry matter yields, crude protein contents, and digestibilities of dry matter. Lemtal, an Italian ryegrass, is presently recommended in the Atlantic provinces and promising new cultivars are being tested in the region.

Italian ryegrass should be seeded as early as possible in spring for high yields. Though seeding rates of 20 to 35 kg/ha are commonly recommended, our data suggest that a rate of 10 to 15 kg/ha is adequate. Under good conditions, seeding rates even lower than 10 kg/ha have resulted in good stands. Weeds may depress the seedling growth and they should be controlled by timely defoliation or by spraying with suitable herbicides. Weeds are not usually a problem after the first harvest due to vigorous competition from ryegrass.

Adequate soil fertility is important in the production of annual ryegrass. Two or three applications of 60 or 80 kg N/ha during the growing season may be necessary to produce vigorous growth and good quality forage from mid-summer to late fall. The dependence of Italian ryegrass on fertilizer nitrogen for high productivity increases the cost of production. One way of reducing

Dr. Kunelius is a research scientist specializing in forage physiology and management at CDA's Charlottetown, P.E.I., Research Station

this cost is to grow a nitrogen-fixing forage legumes with it. Red clover (*Trifolium pratense*) and Persian clover *(T. resupinatum)* grow vigorously and are suitable legumes to be included in mixtures with Italian ryegrass.

Italian ryegrass seeded in late April or early May is usually ready for grazing by early July, or it may be used for conservation purposes somewhat later. It grows vigorously after defoliation. Although regrowth intervals from 3 to 6 weeks have produced almost equal dry matter, crude protein, and digestible dry matter yields, maximum yields were obtained with a 4-week regrowth interval (see Table). Crude protein and digestibility of forage with these intervals remain high.

An important characteristic of Italian ryegrass is its ability to grow in cool, late fall conditions. Dry matter production is quite evenly distributed through mid-summer and fall. Since perennial forages tend to produce most of their dry matter in early summer, Italian ryegrass may be used to supplement forage production in late summer and fall. Furthermore, perennial forages should not be grazed or harvested during September, allowing them to accumulate adequate reserves for overwintering. During this period Italian ryegrass provides good quality forage for grazing.

Westerwolds ryegrass produces high yields with excellent quality in the year of seeding. The growth is stemmier than that of Italian ryegrass.

Low dry matter content of Italian ryegrass may make it a difficult crop to conserve. Wilting harvested grass to 25 to 35% dry matter improves silage quality and eliminates excessive seepage from the silo. Field curing for hay may be difficult, particularly under humid conditions. Spoilage occurs readily unless low moisture content in hay is attained.

Our results indicate that Italian ryegrass, grown as a summer annual, produces satisfactory dry matter yields of high quality. Due to its growth pattern, it is suitable for mid- to late season production and provides a much needed forage for livestock at that time. ■

MEAN DRY MATTER, CRUDE PROTEIN, AND DIGESTIBLE DRY MATTER YIELDS AND PERCENT CRUDE PROTEIN AND IN VITRO DIGESTIBILITY OF DRY MATTER OF ITALIAN RYEGRASS

N rate, kg/ha†	Dry matter kg/ha	Crude protein %	Crude protein kg/ha	Digestibility of dry matter %	Digestible dry matter kg/ha
0	2670	14	375	77	2050
40	4750	16	781	77	3680
80	6040	19	1163	76	4550
120	6620	21	1375	77	5130
Regrowth interval weeks					
3	4930	22	1106	79	3890
4	5990	19	1163	78	4670
5	5520	18	1019	76	4210
6	5900	17	1000	73	4300

†Per application, applied at emergence and after the first and second harvests.

THE BEET WEBWORM: RETROSPECT AND PROSPECT

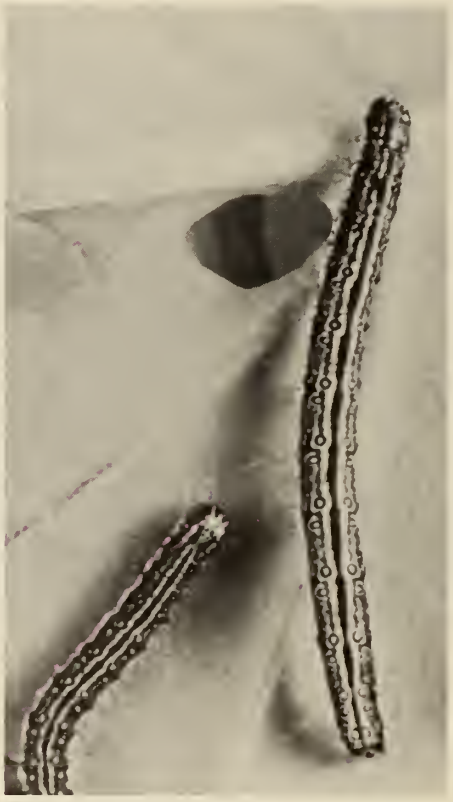
L. G. PUTNAM

L'avenir de *Loxostege sticticalis* semble assuré en Saskatchewan bien que ses périodes de pointe restent incertaines. La poursuite de la surveillance et de la recherche sont nécessaires pour avertir des recrudescences possibles.

During its brief time as a developed agricultural area, Saskatchewan has experienced outbreaks of the beet webworm (*Loxostege sticticalis* L., Lepidoptera: Pyralidae). Saskatchewan shares this species with adjacent Prairie Provinces and neighboring north central American states. *L. sticticalis* is also extensively distributed in the rest of the northern hemisphere. In Europe, it has been a pest in some of the Mediterranean countries. More especially, it was notorious in both European and Asiatic USSR in the decade of the 1930s. It would seem to be of interest to consider this species historically as an insect pest problem in Saskatchewan, and to speculate on its future on the basis of the record.

Pioneer entomologists of the Prairie Provinces made reference to the beet webworm in an early crop protection leaflet. Mention was made of a tremendous outbreak in southern Alberta in 1919. When abundant it attracted attention, and reference was made in routine reports of the old Dominion Entomological Laboratory at Saskatoon, as well as in the Canadian Insect Pest Review. Research on the beet webworm was nor formally established as a project in Saskatchewan; reports therefore tend to be given in descriptive and not quantitative terms. They are nevertheless thought to be highly suggestive of the situations as they were then.

Mr. Putnam is an entomologist at CDA's Research Station, Saskatoon, Sask



Larva of the beet webworm, a pest shared by farmers in Western Canada and other parts of the world.

It should be pointed out that *L. sticticalis* is an insect frequently nurtured initially, in the larval stage, on the Chenopodiaceae: lambs' quarters (*Chenopodium album* L.); Russian thistle (*Salsola kali* var. *tenuifolia* Tausch) and beet foliage (*Beta vulgaris* L.). The first two species, weeds, have provided the main beet webworm food base in Saskatchewan where its pest status has frequently depended upon migration of the highly mobile larvae from weeds to broad-leaved horticultural and field crops. Chief among the latter are leguminous forage crops, flax, sunflowers, and the currently important Brassica seed crops. Cereal grains are rarely or never attacked.

Records of *L. sticticalis* in unusually large numbers seem most consistent beginning with the decade of the 1930s. The years 1932, 1937 and 1940 appear to have been outstanding. During some of those years, Russian thistle was looked upon as a last-resort fodder and the beet webworm fed heavily upon this weed.

In the decade of the 1940s, *L. sticticalis* continued to be noted with some regularity, but the peak populations were less dense and the economic larval populations of a more local and scattered character. After 1949, very little note was taken of it until 1956. In 1958, an outbreak was described as "the most widespread and severe in Saskatchewan for 25 years." This embraces a period going back to 1933, and as a descriptive statement seems to ignore 1937 and 1940, also regarded as exceptional at those times. The outbreak that began in 1958 involved the northeastern part of the agriculturally developed part of Saskatchewan. Rapeseed had become an important crop there and was under attack. The outbreak continued at a declining level until 1962.

A research project on insects that attack Brassica seed crops began in 1961, and from that year moths of *L. sticticalis* captured in light traps were counted. Beet webworm moths have been captured in light traps in Saskatchewan in greater numbers than any other lepidopteran. Nearly 11,000 were taken during the 1961 season at the Aylsham trap in northeastern Saskatchewan, a year of de-

clining abundance. The decline continued until 1968, after which an increase began, culminating in an outbreak in southern Saskatchewan in 1971. In that year, about 27,000 were taken at Indian Head. A rapid decline set in the following year, reaching a low level of only about 50 moths per trap in 1974 and 1975.

In the most recent year, 1976, there was evidence of a trend of recovery, and subsequent developments will be watched with interest. Thus the moth capture data have already recorded the decline of one peak and the rise and decline of another. The fluctuations are obviously of wide amplitude, a situation typical of many insect species resident in Saskatchewan.

Farm practices have had an effect on the abundance of the beet webworm in Saskatchewan. In the absence of a sugar beet crop, the species is largely dependent upon weeds as an initial food base. Widespread weed control with herbicides has markedly reduced its food supply. The recent culture of more than a million acres of susceptible Brassica crops in Saskatchewan each year, mostly concentrated in the park belt and transition zones, has not provided a substitute food. Although we have evidence that *L. sticticalis* can still fluctuate within wide limits, the very impressive profusion of the species as described for several years in the decade of the 1930s and before has not been repeated recently. It may be more than coincidental that the species has been little reported from the Soviet Union since the 1930s.

It can be assumed that factors other than the food supply also affect abundance. For example, the prepupal and pupal stages are spent in a cocoon in the soil. Some of the spun-up larvae or prepupae remain in diapause through the winter to pupate in the spring and produce the new moth flight. The seasonal pattern of moth emergence is highly variable from year to year. For good synchronization of the first (and often probably only) larval brood of the season to food plant development, moth flight should probably be maximal in June, and this does not always occur. Weather is likely to affect abundance, but the processes through which this influence might work are not known. Several other factors have been suggested as critical for reproductive success, such as quality of larval diet, quality of nectar in the moth diet, and a complex of parasites. All remain unevaluated for Saskatchewan conditions.

Judging from recent experience, the future of *Loxostege sticticalis* as an abundant species, if not as a pest, seems assured; but the levels to be attained during its peaks of abundance remain in doubt. One suspects, intuitively, that while its better food plants, i.e. weeds in Saskatchewan, are controlled as well as they have been in recent years, the large clouds of moths and overwhelming armies of caterpillars formerly seen are not likely to recur. But this assumption is not made on a sufficiently substantial basis to support a policy of no further monitoring or research of the species. ■

NEW APPROACH TO SCALE CONTROL

R. S. DOWNING and
D. M. LOGAN

La pulvérisation de diazinon sur les arbres fruitiers de Colombie-Britannique au moment de la chute des pétales, juste avant l'émergence de la cochenille mâle de San Jose, s'est révélée efficace dans la lutte contre cet insecte. Les scientifiques de la station fédérale de recherche de Summerland (C.-B.) recommandent l'addition de cet insecticide aux pulvérisations de dormance comme solution de rechange aux pulvérisations de juin et de juillet lorsque l'insecte est à son état nymphal.

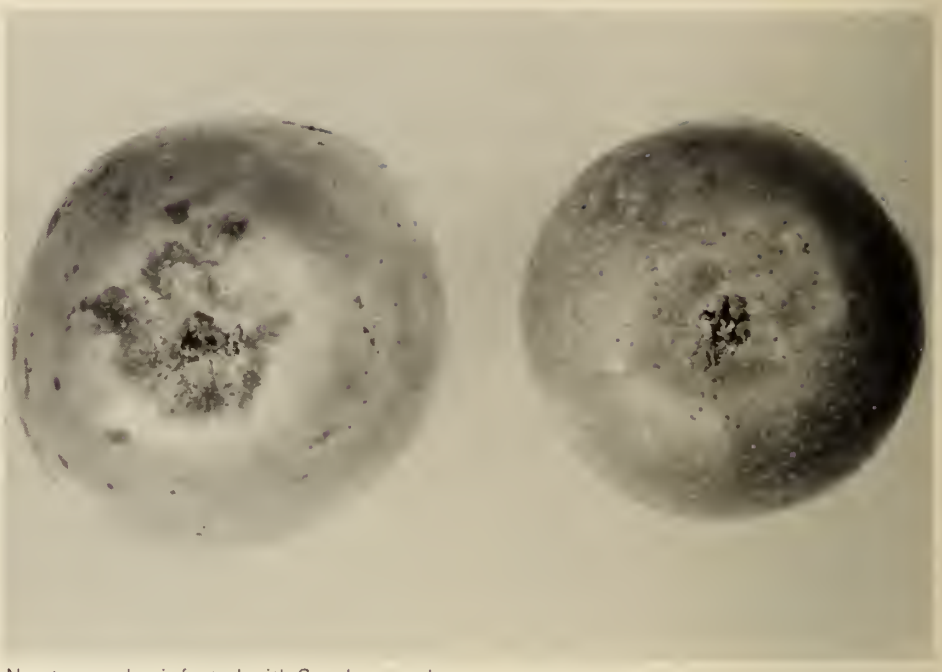
The San Jose and European fruit scales are serious orchard pests in British Columbia. Both species can cause considerable losses by marking the fruit. Fruit packers in the south Okanagan and Similkameen Valleys where the San Jose scale is found say that yearly losses aver-

Mr. Downing is an entomologist and Mr. Logan a technician at CDA's Summerland, B.C., Research Station.

...yearly losses of 15%

age 15% and some growers have lost 75-100% of their fruit. The European fruit scale is not considered to be as dangerous but is prevalent over a larger area from Penticton to Vernon. Crop losses of 25% caused by this pest have been reported recently.

The San Jose scale, which is native to China and is sometimes called the Chinese scale, was introduced accidentally into San Jose, Calif., in the 1870's and has since spread to all the fruit-growing areas of North America, including British Columbia where it was first found in 1916. The European fruit scale, as its name implies, came from Europe and is present in Eastern Canada, the northeastern United States and northern Oregon as well as British Columbia where it has been present since the early 1900's.



Newton apples infested with San Jose scale on the left and European fruit scale on the right.

Both scale insects feed by inserting their needle-like mouth parts into the bark, leaves, or fruit of orchard trees, injecting saliva which breaks down the cells enabling the insect to freely suck up the plant juices. The saliva is often toxic to the plant and the loss of the juices devitilizes the plant and sometimes results in the death of twigs, branches, and the whole tree. The San Jose scale is the more important of the two and some countries have a quarantine against it.

Scales are not often recognized as insects because during most of their life they are immobile and covered with a dark grey or black shell commonly referred to as a "scale". The yellow insects live underneath the shells for most of the year. Adult males have wings, legs, antennae, and eyes. Females do not develop these structures and, unlike the males, never leave the shells.

Both San Jose and European fruit scale reproduce sexually. The females, after fertilization by the male, give birth to living young, called crawlers. Most of the crawlers leave the shell to settle and feed elsewhere on the plant but some stay underneath the shell and as they grow the old shell is lifted up to form a protective cover for the new scale. This may happen three or four times until the bark becomes encrusted with scale, and under these conditions it is difficult to kill the live stationary insect with a contact poison.

The San Jose scale overwinters as a first nymph called the blackcap stage. Most control procedures are aimed at killing this, usually with petroleum oils. Without doubt, the oil is very toxic because if oil contacts the scale, the little insect underneath will be killed. However, because the insect can be protected by layers of old dead scale or by bark, the oil may not contact the scale. These surviving scale insects continue their development to the adult stage. The mature winged male emerges from underneath its elongated shell at about the petal fall stage of apple bud development and then searches for the females by walking or flying. Because of this necessary mobility of the male, it is probably the weakest link in the life history of the insect.

In 1976, we conducted laboratory experiments with the male San Jose scale and found that the organophosphate diazinon would kill the male before it emerged from un-

derneath its scale, allowing no reproduction at all. This experiment was extended to an apple orchard that was heavily infested with San Jose scale. The whole orchard was sprayed with oil at the ½-inch green bud stage to kill a high percentage of the overwintered black cap stage. Part of the orchard was later sprayed with diazinon at the petal fall stage, just before the males started emerging. Another part was sprayed three times with diazinon in late June and July when the crawlers were emerging, a recommended and common procedure. Another part of the orchard had no other sprays for scale control except the oil spray.

The experiment was repeated in 1977 but that year only two sprays were applied to control the crawlers because of a shorter emergence period. The one spray of diazinon applied against the males gave excellent control both years and was as effective as two or three sprays directed against the crawlers. The male scale emerges over a period of 2 or 3 weeks whereas the crawlers emerge over a period of 6 to 8 weeks requiring more sprays to cover the extended period of emergence. The petal fall spray is being recommended in 1978 for San Jose control as an addition to the earlier oil spray and as an alternative to the June and July sprays directed against the crawler stage. The petal fall spray of diazinon is also useful for the control of budmoth, green fruitworm, Pandemis, thrips and Campylomma.

The European fruit scale overwinters in the second nymphal stage and as this scale has only one generation per year, compared to two for the San Jose scale, oil applied at the ½-inch green to tight cluster stage is the only recommended control measure in British Columbia. However, the European fruit scale tends to inhabit the rougher bark on the trunk and main limbs of apple and pear trees where it can live in protected sites. Consequently, it is difficult to obtain complete coverage of these scales with the oil spray. Therefore, experiments are planned to evaluate the effectiveness of sprays applied against the male European fruit scale with the hope that the procedure will be as successful as against the San Jose scale. ■

ROOT ROT OF CEREALS — EVERYONE'S PROBLEM?

HOWARD HARDING

La maladie qui réduit le plus le rendement des cultures de céréales est le piétain ordinaire. A la station fédérale de recherches de Saskatoon (Saskatchewan), le programme de lutte contre cette maladie est surtout axé sur la sélection de variétés immunisées. Le plan d'attaque consiste à croiser les variétés les plus résistantes dans l'espoir d'obtenir une ou plusieurs lignées de reproduction. Jusqu'à présent, les chercheurs n'ont pas trouvé de matériel complètement résistant ou immun au piétain ordinaire.

Dr. Harding is a plant pathologist at CDA's Saskatoon, Sask., Research Station.

We may sometimes forget that bountiful grain supplies are not our birthright. In any one year several unpredictable factors can adversely affect crop yields. In addition to the weather, the grain growers have to contend with a variety of insect pests and diseases. The weather, prayers notwithstanding, cannot be controlled; diseases can be — to a point. The various disease-causing organisms change just as the crop is improved by the plant breeder. Rust is the classical disease of cereals and the continuing struggle to stay ahead of new rust races is well known.

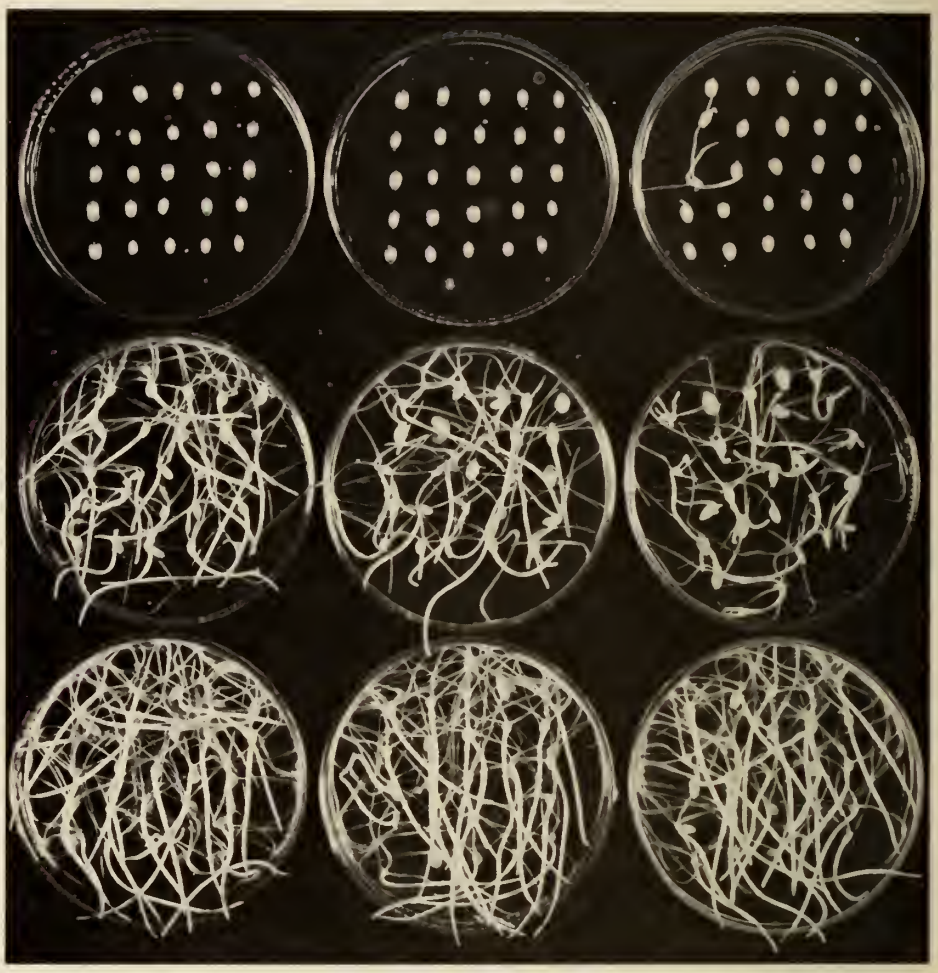
Today, however, the disease that causes the largest loss in yield is common root rot. It is not a spec-

...attacks wheat and barley

tacular disease like rust but it is more a debilitating disease and obvious signs of its presence are not often seen. It is primarily a disease of wheat and barley, attacking the base of the crown and the sub-crown internode. Thus the flow of water and nutrients to the leaves, stem, and heads is interrupted. In Western Canada it causes an average annual loss of about 7% of the wheat crop and somewhat more for barley. This may not seem like very much, but an average of 10.8 million hectolitres of wheat is lost annually in the three Prairie Provinces. Think of it in terms of dollars and cents . . . !

The disease is not restricted to Western Canada. It is equally important in the upper Great Plains region of the United States. In those areas of the U.S.S.R. where wheat is grown on marginal land, common root rot is often the factor limiting production. Even in the more productive soil zones of the U.S.S.R., it probably causes losses well in excess of 7%. In the early years of this century, this disease caused almost total crop failure in certain areas of Australia where it is still a major cause of concern. In India, at least three states consider it to be a major disease. It is also found in Argentina, but its importance there has not been as well documented. In Eastern Canada, and increasingly in Europe, the pathogen comes from underground and attacks the foliage, particularly of barley. This is the disease known as spot blotch.

What causes common root rot? Several pathogens are involved to some extent but by far the most important in this country is a fungus known as *Bipolaris sorokiniana*. This fungus was apparently first described in the U.S.S.R. late in the nineteenth century and was given the name *Helminthosporium sorokinianum*, in honor of the man who first found it, N. Sorokin. In 1910 it was reported independently in Iowa and given the name *Helminthosporium sativum*, which is perhaps its most common name. It surfaced a few years later in Sweden as *Helminthosporium acrothecioides*.

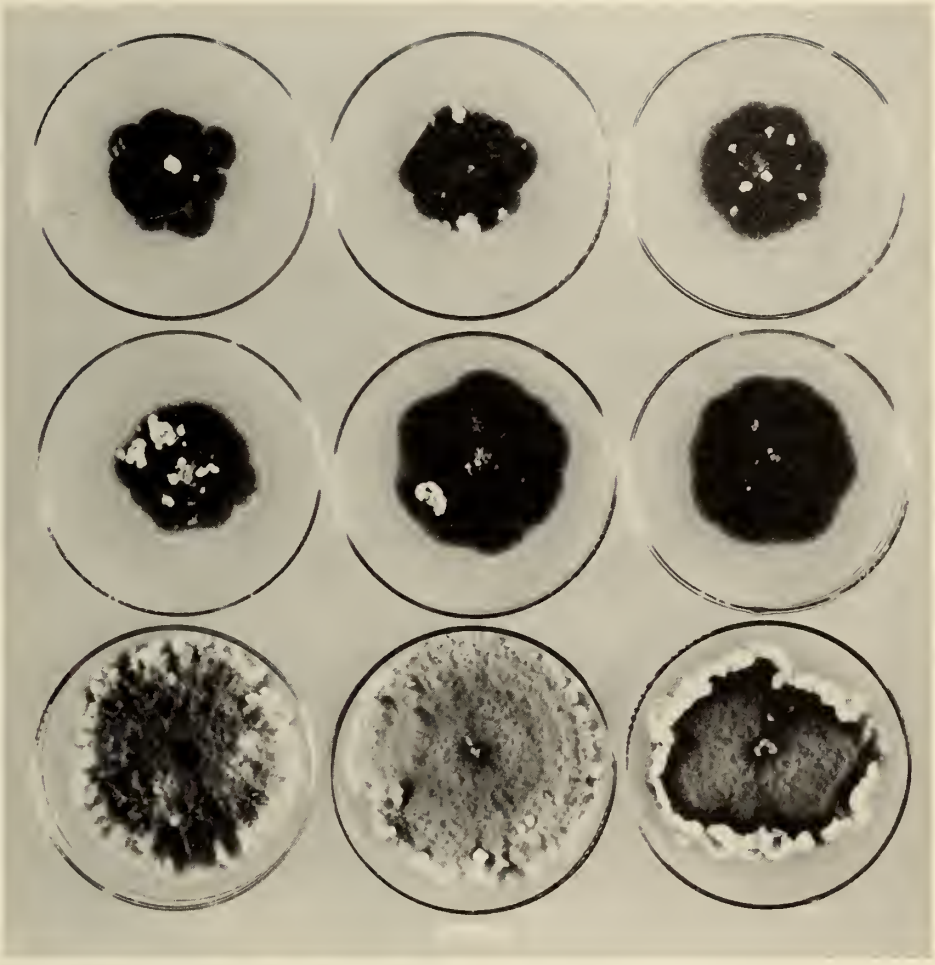


Inhibition of germination of wheat seeds caused by toxins produced by the pathogen The top row shows complete inhibition, the middle row shows an intermediate reaction and the bottom row shows no inhibition of germination

Helminthosporium is a large and unwieldy assemblage of fungi that includes species that will attack anything from cows to coconuts, including man. However, within this all-encompassing generic term are some well-defined groups. In economic terms, the most important are those that attack cereals and grasses. The genus *Bipolaris* was set up to accommodate one of these groups

and it includes those pathogens that cause southern leaf blight of corn, brown spot of rice and victoria blight of oats, plus a few other characters. It also, of course, includes the fungus which causes common root rot of wheat and barley — *Bipolaris sorokiniana.*

How do we control the disease? Several agronomic and cultural approaches have been tried but generally they are at best only palliative measures. Rotations with non-host crops may reduce the population of spores in the soil but rarely to below the threshold necessary for disease to occur. Fertilizers, particularly phosphate, seem to have an alleviating effect by increasing the general well-being of the plant. Currently, fungicides are less than fashionable ecologically. However, work in Eastern Canada indicates that spot blotch can be effectively and economically controlled by properly-timed fungicide sprays. Seed treatment so far has not proven an effective control measure for common root rot, but some initial work being done at Saskatoon seems promising.



Variability in appearance of nine isolates of the pathogen grown in culture.

At Saskatoon, the main thrust is in the direction of breeding for disease resistance. Over the years the level of resistance to common root rot has generally increased. Thus, on a scale where 100 represents complete susceptibility and 0 complete resistance, the disease rating of Marquis wheat is about 45 while that of the more recently licensed Neepawa is about 15. This improvement has come about largely because yield and quality trials of new wheat cultivars have been conducted in areas where the disease is prevalent; the better yielding cultivars have carried some resistance to root rot. We are now breeding and selecting for even better resistance to the disease, in co-operation with plant breeders at Winnipeg, Lethbridge, Swift Current and Saskatoon. Generally, the plan of attack is to intercross all of our best sources of resistance with the expectation of combining most of the available resistance in one or more breeding lines. Currently, testing for resistance is done in field plots, but this practice limits the number of lines that can be screened at one time. For this reason we are trying to develop rapid laboratory screening methods, using toxins produced by the pathogen. This approach has been used successfully in some other related host-parasite systems.

So far, we have not found any material that is completely resistant or immune to common root rot. Perhaps this is not a bad thing. In nearly all cases where disease resistance has resided in immunity based on one or a few 'major' genes,

...searching for new races

a new race of the particular pathogen has appeared and effectively nullified that resistance. The devastating 1970 epidemic of southern corn leaf blight, caused by *Bipolaris maydis*, emphasized the dangers inherent in growing large acreages of cultivars with identical genotypes for disease resistance.

Against this background of concern we are continually monitoring the variations in a natural population of *Bipolaris sorokiniana.* We are trying to find new races before they find us, so to speak. Of course, we cannot hope to check out all variations; we do check their appearance when growing in culture, their ability to produce toxins, their electrophoretic protein profiles and their pathogenicity. We also keep an eye on the sexual activities of the fungus. In any organism, the occurrence of a sexual stage, with its reassortment of genetic material at meiosis, affords a great opportunity for the production of new 'types'. Fungi are no exception. The rationale behind the eradication of the barberry was, of course, to cut down on the sex life of the stem rust fungus. The sexual, or perfect, stage of *Bipolaris sorokiniana* is known from laboratory culture and it has its own name, *Cochliobolus sativus*. This stage has not been found in nature; however, there is no obvious reason why it should not occur. Thus, while characterizing isolates by their morphological features and pathogenicity, we also check their mating types and any other factors that may be important in regulating the occurrence of the perfect stage.

Threshing single heads from a wheat plant with superior root rot resistance.

So, given the history of breakdowns in disease resistance and the great variability of the pathogen, can we control common root rot, or are we on what E. C. Stakman called "the plant pathologist's never-ending merry-go-round"? Can we get the disease ratings of Neepawa's descendants down from 15 to 5 without encountering a new race problem? We could not answer that question, even if all other factors

Breeding lines growing in field plots. Any one of these could be used to emphasize the number of lines being screened and the range of plant types encountered.

remained equal. Of course, all other things do not remain equal. New agronomic practices, such as chemical summerfallowing, or new breeding procedures, such as incorporating bits of alien germplasm into new cultivars, may alter the scenario overnight. We may wind up struggling to maintain the 15% level. And so the research must continue. While some research is being done in the universities, most of the work on grain improvement, in yield, quality and disease resistance, is being done in the Research Branch of Agriculture Canada, by the successors of William Saunders and the experimental farms system which produced the catalyst that started it all in the first place: Marquis wheat. ■

ECHOES
FROM THE FIELD AND LAB

ECHOS
DES LABOS ET D'AILLEURS

NEW BARLEY THEORY Barley yields are more closely linked to growth before ear-emergence than after it, according to research at the Macaulay Institute for Soil Research, Aberdeen, Scotland.

The scientists say emphasis should be given to proper nutrition of the plant before ear-emergence, not after. Results of sample weighings of the dry matter content from the four-leaf stage of harvesting showed that the final grain yield was better correlated with the dry matter produced before ear-emergence than that produced after ear-emergence.

This suggests that if farmers don't get the required plant growth before ear-emergence, they have little hope of making up the loss later. Crops must start with enough phosphate and potash in the soil and get adequate nitrogen input.

SOIL CLASSIFICATION The Canadian System of Soil Classification is a new publication that outlines the Canadian system of soil taxonomy. It replaces The System of Soil Classification for Canada. Included in the book are chapters on each of the nine soil orders including the recently developed Cryosolic order. Other chapters describe the family category, correlate the Canadian system with others and outline the terminology used in describing soils. The recently developed system of landform classification for soil surveys is also described. The book contains 50 color photos and 17 line drawings, 17 chapters and 164 pages.

Prepared by the Classification Subcommittee of the Canada Soil Survey Committee, the book is available from the Publishing Centre, Printing and Publishing, Supply and Services Canada, Hull, Quebec K1A 0S9. The price is $9 in Canada and $10.80 (Canadian funds) for other countries. Cheques or money orders should be made out to the Receiver-General for Canada.

PEATLAND TRACTOR A peatland tractor designed specifically for horticultural work on Newfoundland peatlands has been designed and built by Agriculture Canada's Engineering and Statistical Research Institute. It is being tested this summer at the department's peat research substation at Colinet, 90 km southwest of St. John's.

About 400 000 ha of the island's 2 000 000 ha of peat bogs are suitable for agriculture, especially for forage crops and vegetables such as root and cole crops.

Peat bog reclamation is still in its infancy, although research has been ongoing for 21 years. Part of the slow development was due to the lack of machinery to work in bog conditions. Existing tracted tractors used on the St. John's West Research Station were unsuitable because of the wide track width needed to support the heavy units on peat soils. Machines with a combination of narrow tracks, low ground pressure, high clearance and agricultural hitching were not available.

The new peatland tractor has been designed especially for work in row crops. It has a track width of 330 mm, and with a ground clearance of 750 mm, it easily clears crops grown on the ridges necessary for vegetable production on Newfoundland peat soils. An articulated tractor, it has three-point linkage and power take-off attachments at the rear. It has the flotation required for relatively wet conditions and the capacity to operate power equipment such as light to medium rotovators, rotoridges and root crop harvesters. The peatland tractor weighs 2000 kg and has a horsepower et 30 kW.

The driver's seat is high to allow observation of power implements behind and a roll bar protects the driver.

Recommendations for the machine were made by A. F. Rayment of Agriculture Canada's St. John's West Research Station. It was designed by Gary Hergert of the department's Engineering and Statistical Research Institute (ESRI) in Ottawa and built by Bruce Compton and Bill Jahn also of ESRI.

A combined ridger and seeder to be used with the peatland tractor is being developed at Memorial University.

The peatland tractor is demonstrated by Gary Hergert of Agriculture Canada's Engineering and Statistical Research Institute.

SAVE ENERGY Increasing energy costs will continue to improve the practicality of minimum tillage systems provided they are agronomically sound, says Wayne Lindwall, a tillage engineer at CDA's Lethbridge, Alta., Research Station.

Crop yields, or energy outputs, for reduced tillage and zero tillage systems were 16% and 9% higher, respectively, than those from the conventional tillage system at the Research Station, M. Lindwall says. The ratios of total energy output to input were 6.8:1, 11.0:1 and 17.4:1 for the conventional, reduced and zero tillage systems. Although zero tillage reduces energy inputs, he says it is still not economical for most farmers to eliminate fallow tillage because the best herbicides are too expensive.

TO RESEED OR NOT RESEED Lower flax yields may be better than yields from a reseeded crop, says a scientist at CDA's Morden, Man., Research Station. Besides the extra cost of the seed, tillage and seeding, reseeding often results in lower yields because of the later seeding date and the loss of moisture from the additional tillage, says G. H. Gubbels, in charge of physiology management at the Station. His experiments involved three varieties of flax — Linott, Noralta and Nored – that in two years had yields reasonably similar in plant stands with counts from 250 to 500 plant/m^2. As stand counts dropped below 250 plants/m^2, yield tended to drop off. However, even at plant counts as low as 125/m^2 yields were reasonably good due to extensive tillering.

NEW PUBLICATION Field Crops Research is a new international journal that publishes papers concerned with biological and physical research on field crops in the areas of crop agronomy, improvement, physiology, ecology, protection, soil and water management and farming systems. The journal's editor-in-chief is M. J. T. Norman of the department of agronomy and horticulture science, University of Sydney, Australia. Field Crops Research is published quarterly by Elsevier Scientific Publishing Company, Amsterdam. Subscription price is US $62.25, including postage. Free sample copies are available upon request from the publisher at Jan van Galenstraat 335, P.O Box 330, Amsterdam, The Netherlands.

SWAMPLAND RECLAIMED An area of 752 sq km, formerly swampland, is being used to rear about 4,300 head of young cattle in the district council of Lubben, German Democratic Republic. The area has

been drained and irrigated and is being farmed by the Spreewold state farm, says W.L. Pringle of CDA's Beaverlodge, Alta., Research Station. Mr. Pringle visited the site during the International Grassland Congress held in Leipzig. The Spreewold state farm plans to bring 56,000 ha into production by 1980 with up to 60,000 head of cattle (1.07 head/ha).

BIONIC WEEDS? More and more weed species are showing resistance to atrazine, a commonly used herbicide. To date, strains of lamb's quarters, pigweed, ragweed and bird rape have shown resistance, says A.S. Hamill of CDA's Harrow, Ont., Research Station. Dr. Hamill is also Chairman of the eastern section of the Canada Weed Committee.

Also, weeds that weren't a problem a few years ago are becoming one now and are spreading to more farms. Examples are giant foxtail, nutsedge and velvet leaf in Ontario. In the Atlantic Provinces, problems with barnyard grass and crabgrass are increasing as are sites of ragweed, goldenrod, field mint and horsetail. In Quebec, problems with wild oats, corn spurry and fall panicum are increasing

BLACKFLY CONTROL It's difficult to control blackflies without harming the environment. This is especially true of the type that breed in small streams as opposed to those breeding in large rivers, says Dr. K. R. Depner, as entomologist at Agriculture Canada's Lethbridge, Alta., Research Station.

Small streams are more numerous than large rivers and so breeding sites in small streams are also numerous. Concentrations and distribution of larvicides on small streams are more difficult to control so the chance of environmental damage is greater.

Application of insecticides from aircraft is imprecise so the chance of environmental damage is greater. Hopefully, a few point application of larvicides in small streams will reduce adult blackfly population within limited problem areas.

Population of large-river blackflies can usually be reduced with one application of larvicide to the river just before population in the spring.

ALFALFA IN WESTERN CANADA To do well in western Canada, alfalfa varieties must be winter hardy. Bernie Goplen of CDA's Saskatoon, Sask., Research Station recently tested 25 strains and varieties of alfalfa. All of them did reasonably well through two Saskatoon winters, but not so well through a third, more severe, winter. He found that alfalfa strains and varieties bred in western Canada suffered an average of only 3% winter kill, while varieties bred in eastern Canada and the United States suffered an average 46% winter kill. Dr. Goplen stresses this doesn't mean the varieties developed in eastern Canada and the United States are no good. They are excellent for those parts of the country. Use the variety bred and recommended for your own area, he advises.

OUTLOOK BRIGHT FOR CANDLE The rapeseed variety Candle is ready to join Canada's rapeseed industry. Three years of co-operative testing have shown its oil erucic acid content to be 1 to 2%, and its meal to have a glucosinolate content of 1 to 2 milligrams per gram. Candle's yields have averaged 89.2% of Torch, and in 1977 its oil content was 2% higher than Torch. Early research indicates Candle meal is at least equal to Tower meal.

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